CHAPTER ONE

The Instrument

How a loom was built, and what its dimensions were made to hold

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> *A loom is not a machine that makes cloth. It is a machine that holds thread still enough for a human hand to make cloth.*
>
> — a weaver's distinction, remembered

Before there is a fabric there is a frame, and before the frame there is a decision about tension. Everything a loom does — everything it has done for four thousand years across the Indian plain — follows from a single problem: a thread, on its own, will not stay where you put it. Stretch a few hundred of them side by side and they sag, drift, cling to their neighbours, and snarl. The whole art of the loom is the art of governing that unruliness — of holding one set of threads rigid and parallel while a second set is passed through them at right angles, over and under, again and again, until the two lock into a plane. Strip away the carving, the regional names, the ritual that grew around the craft, and a loom is only this: a device for keeping the warp still and the weaver's hands free.

This chapter is about the device itself — not the weaver, not yet the cotton, not yet the empire that would come to break the trade. Those belong to later chapters. Here the concern is mechanical and almost stubbornly literal: what the loom was made of, how it was set into the ground, what its parts did, and above all what its dimensions were — because the fineness of Indian cloth, the thing the world would eventually cross oceans to buy, was written into the geometry of the frame long before a single pick of weft was thrown. To understand what was lost, one must first understand what was built. We begin with the wood in the ground.

THE PIT, AND WHY THE LOOM WENT INTO THE EARTH

The most common loom of the Indian plains was not a piece of furniture standing in a room. It was dug. The weaver excavated a pit, roughly knee-to-waist deep and wide enough for two feet to work, and set the working frame at ground level above it. This is the *pit loom*, and its defining feature is that the weaver sits at the floor's edge with legs down in the pit, feet resting on treadles below ground while the warp runs out level in front at the height of the lap.

The reasons were not decorative. A loom sunk into the earth is braced by the earth: the pit walls and the buried posts give it a stability that a free-standing frame, rocking on a mud floor, could never match. The ground also did something subtler and much prized — it kept the cotton yarn cool and slightly damp. Cotton spun fine is brittle when dry and supple when it holds a little moisture, and a pit in a packed-earth floor, especially in a humid weaving town, held humidity around the working threads and reduced breakage. And by moving the shed-changing mechanism below the floor and working it by foot, the pit freed both of the weaver's hands for the one task that could not be automated: sending the shuttle across and beating the cloth home.

So the choice to dig was a choice about tension, climate, and labour all at once — the first of many places in this book where a piece of Indian craft that looks humble turns out, on inspection, to be an exact solution to several problems the weaver never wrote down.

THE SKELETON: POSTS, BEAMS, AND THE TWO ENDS OF THE WARP

Above the pit stood the frame proper, and its logic is best understood as a struggle between two beams at opposite ends of the weaver.

At the far end, away from the weaver, sat the *warp beam* (the back beam) — a stout wooden roller onto which the entire length of the warp, often many metres of it, was wound. At the near end, against the weaver's body, sat the *cloth beam* (the breast beam), onto which the finished fabric was rolled as it was made. Between them the warp threads ran taut and horizontal, and the whole drama of weaving happened in the span of a hand's breadth just in front of the weaver's chest. The two beams were mounted through holes in the upright posts, and each carried a simple but essential brake: a bamboo stick passed through a hole in the beam and jammed against a fixed horizontal member, locking the roller so the warp could not unwind and slacken. Weaving is only possible under tension; the brake is what guaranteed the tension never let go.

The uprights themselves — four posts in the fully developed fly-shuttle version, sometimes fewer in the older throw-shuttle pit loom — carried everything above: the beams, the suspended harnesses, and, in the improved looms, the swinging beater. The materials were what the region gave: hard local timber for the posts and beams, bamboo for the lighter members and for

the reed's frame, cotton cord and leather for the ties and straps. Almost nothing was fastened permanently. A loom of this kind could be dismantled, carried, and reassembled; much of it was lashed rather than nailed, so that a member which wore out could be replaced without rebuilding the whole. It was, in the exact sense, an *appropriate* technology — repairable at home, from local stock, by the person who used it.

THE THREE MOTIONS, AND THE PARTS THAT MAKE THEM

Every loom on earth, from a buried pit loom in a Tamil village to a screaming air-jet machine in a modern mill, performs the same three primary motions in the same order. The Indian handloom performed all three by the weaver's own body. Name them and the whole instrument comes into focus.

Shedding — opening the warp

The warp threads are divided into two sets — odd and even, say — and one set is lifted while the other stays down, opening a triangular gap called the *shed* through which the crosswise thread can pass. This is done by the *heddles* (also called healds): loops of strong cord, each with a small eye at its centre, and a single warp thread threaded through each eye. The heddles hang in *harnesses* (shafts) suspended from above. When the weaver presses a treadle in the pit, a harness rises, and every warp thread running through its heddles rises with it. Release it, press the other, and the sets reverse: the shed that was open closes, and its opposite opens. In the simplest and most common cloth — *plain weave*, the tabby — there are two harnesses and two treadles, and the feet alternate in a rhythm that becomes, after years, wholly unconscious.

Picking — passing the weft

With the shed open, the weaver sends the crosswise thread — the *weft*, or filling — across the warp. It is carried inside a *shuttle*: a smooth wooden boat, pointed at both ends like the hull of a canoe, hollowed to hold a *quill* or *pirn* on which the weft yarn is wound. In the older *throw-shuttle* loom the weaver literally threw the shuttle from one hand, caught it with the other, and threw it back — which meant the cloth could be no wider than the span of two arms, and set a natural ceiling on the width of a single-weaver fabric.

The *fly-shuttle*, a later improvement, changed this. The shuttle now sat in a box at each end of a race-board, and a *picker* — driven by a cord the weaver jerked with one hand — flung it across the shed and into the opposite box. One hand, one string, and the shuttle flew on its own. This single device multiplied a weaver's output three- to fourfold and allowed wider cloth from one pair of hands — and it will matter a great deal, later in this book, that so much more could be got from the same worker by so small a change in the frame. But the fly-shuttle bought its speed at a price the old loom did not pay: it could not manage the most intricate extra-weft figuring that the hand-thrown shuttle allowed. Speed and ornament pulled against each other, as they so often would.

Beating-up — driving the weft home

A single passed weft thread lies loose in the shed; it must be driven back and packed tight against the cloth already made. This is done by the *reed*, held in a swinging frame called the *sley* or *batten*. After each pick the weaver pulls the sley toward the chest, and the reed combs the new weft firmly against the *fell* — the growing edge of the cloth. Then the shed changes, the shuttle flies back, and the reed beats again. *Lift, throw, beat. Lift, throw, beat.* The sequence repeats, by hand and foot together, some tens of thousands of times in a single length of cloth, until the plane of fabric grows and is wound, inch by inch, onto the breast beam.

THE REED: WHERE FINENESS IS DECIDED

Of all the parts, one deserves to be lifted out and examined on its own, because it is the part that governs how fine — how close-set, how dense, how much like breathed air — the finished cloth can be. That part is the *reed*.

A reed is a comb. In the traditional Indian loom it was made of fine, flat slips of bamboo set side by side between two bamboo ribs that clamped them top and bottom, tight and evenly spaced. Each gap between two neighbouring slips is called a *dent*. Through each dent passes one warp thread — or two, or four, depending on the cloth — and the reed does two jobs at once: it keeps the warp threads spaced apart at a fixed, even width across the whole cloth, and it is the very thing that swings forward to beat each weft home. Spacing and beating, in one instrument.

The fineness of a reed is measured by how many dents it packs into a unit of width — the more dents per inch, the finer the reed, and the closer together the warp threads it holds. And here the single most important number in all of weaving enters the story: *ends per inch*, or EPI — the count of warp threads (“ends”) standing in each inch of cloth width. A coarse cloth might have twenty or thirty ends to the inch. A fine one, a hundred or more. The reed sets this number directly. If a reed has, say, forty dents to the inch and the weaver draws one warp thread through each dent, the cloth will carry forty ends per inch;

draw two threads through every dent and it becomes eighty. The arithmetic is humble and the consequence is total — because ends per inch, more than almost anything else, is what separates a sack from a sari, and what separated ordinary Indian cotton from the legendary muslins that could be drawn, whole, through a finger-ring.

It is worth pausing on how much skill this simple comb demanded of its maker. To weave the finest cloth, a maker first had to *build a reed fine enough* — to split bamboo into slips slender and true enough to stand a hundred or more to the inch without warping, cracking, or drifting out of true under the constant hammering of the beat. The reed-maker's craft and the spinner's craft set the two ceilings on fineness between them: the spinner had to draw thread fine enough to fit, and the reed-maker had to build a comb close enough to hold it. Neither could carry the cloth alone.

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THE LOOM, IN ITS PARTS

A reader who keeps the following names in mind will be able to follow every loom in this book, however its region dresses it up.

Pit — the dug hollow the weaver's legs and the treadles occupy

Warp — the lengthwise threads, held under tension

Weft (filling) — the crosswise thread, carried by the shuttle

Warp beam — back roller holding the unwoven warp

Cloth beam — front roller taking up the finished fabric

Brake — peg locking a beam so tension cannot slacken

Heddle (heald) — corded loop with an eye; one warp thread per eye

Harness (shaft) — frame of heddles, raised and lowered together

Treadle — foot pedal in the pit that lifts a harness

Shed — the gap opened in the warp for the weft to cross

Shuttle — the boat-shaped carrier of the weft quill

Picker — on a fly-shuttle loom, the driver that flings the shuttle

Sley (batten) — the swinging frame that holds the reed

Reed — the bamboo comb that spaces the warp and beats the weft

Dent — a single gap in the reed; holds one or more warp ends

Fell — the growing edge of the cloth, where each weft is packed

EPI — ends per inch — warp threads per inch of cloth width

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WHAT THE FRAME ALREADY TELLS US

We have not yet touched the cotton, and already the loom has told us something the rest of this book will spend chapters confirming. Every capacity of the finished cloth was present, in latent form, in the wooden frame: the width was fixed by whether a shuttle was thrown by arm or flung by cord; the fineness was fixed by the dents of a bamboo comb and the thread a spinner could draw to fill them; the pattern was fixed by how many harnesses the weaver could raise and in what order. Change one dimension of the instrument and you change what the civilisation can wear.

This is why the mechanics come first. When, in the chapters ahead, we watch the fly-shuttle raise a weaver's output and quietly narrow the range of what could be figured; when we watch mill-spun thread of a foreign staple arrive and demand a different reed; when we watch a whole ecology of local timber, bamboo, cord, and repairable joints give way to standardised parts made elsewhere — we will be watching changes to *this frame*. The loom is the ground on which the entire story stands. It held the thread still. What happened to the hands that worked it, and to the fields that fed it, is where we turn next.

CHAPTER TWO

Building the Loom

A construction manual for the fly-shuttle pit loom — exact dimensions, materials, and assembly

The previous chapter described the loom as an idea — the frame that holds thread still. This chapter builds one. What follows is a working construction manual: the timber and its exact sizes, the pit and its depth, the beams and their circumferences, the reed and its count, and the order in which the parts go together. The dimensions given are those of a standard *52-inch reed-space fly-shuttle frame-and-pit loom* — the workhorse of the Indian handloom sector, the same specification issued in government weaver-equipment schedules. A reader with carpentry skill, seasoned hardwood, and these numbers can build a loom that works.

> **Note.** "Reed space" (R.S.) is the loom's working width — the span across the reed available for cloth. A 52-inch loom weaves cloth up to roughly 48–50 inches wide once selvedge and take-up are allowed for. Scale every crosswise dimension with the reed space: a 36-inch loom is the same design, narrower. Lengthwise and vertical dimensions stay the same.

1. MATERIALS — WHAT THE LOOM IS MADE OF

The traditional frame is built of seasoned hardwood — *sal* (Shorea robusta) is the classic choice in northern and eastern India, with *bonsoom* or teak used for the moving parts that must stay true. The wood must be well-seasoned so it does not warp in use; green timber will twist and throw the whole frame out of square. Sand every surface the yarn may touch, and finish with oil rather than paint or varnish — oil keeps the wood from cracking and gives a smooth, renewable surface for the thread to slide against.

Bill of materials — timber

Part	Size (section × length)	Material	Qty
Front posts	4″ × 4″ × 6.5′ (10×10 cm × 2.0 m)	Seasoned sal	2
Middle posts	3″ × 4″ × 6.5′ (7.5×10 cm × 2.0 m)	Seasoned sal	2
Back posts	4″ × 4″ × 3′ (10×10 cm × 0.9 m)	Seasoned sal	2
Side bars (top rails)	Standard, full loom length	Seasoned sal/bonsoom	2
Weaver's seat	1.5″ × 8″ board	Seasoned sal	1
Treadles	1″ × 1.5″ batten	Seasoned sal/bonsoom	2 (up to 4)
Warp beam	hexagonal, 11.5″ circumference	Seasoned sal/bonsoom	1
Cloth beam	round, 8.5″ circumference	Seasoned sal/bonsoom	1
Sley (beater) set	complete, for 52″ R.S.	Bonsoom	1 set

Bill of materials — fittings and yarn gear

Part	Specification	Qty
Country healds	set of 2,160 healds ("21 pone"), No. 2.0 nylon	1 set
Nylon thread	No. 6 (1 kg), No. 4 (0.5 kg), No. 3 (0.5 kg)	as listed
Steel rods	10 mm & 8 mm, ~1.5′, for fixing treadles/beams	as needed
Lease rods	52″ aluminium, set of 4	1 set
Reed	bamboo or steel, count to suit cloth (see §5)	1+
Fly-shuttle	with picker, shuttle-guard screwed (removable)	1–2
Picking cord	strong cotton/nylon, picker to handle	1 set
Pulleys	for heald suspension over top bar	4

2. THE PIT AND THE FRAME — THE STANDING SKELETON

Figure 1 — Side elevation. The pit takes the treadles and the weaver's legs; the warp runs level between the two beams, over the back and front rests.

Begin with the pit, because the frame is set around it. Dig a rectangular pit at the weaver's working position:

Pit dimension	Measurement	Purpose
Depth	70–75 cm (about knee-to-waist)	room for treadles and the weaver's lower legs
Width	90 cm	span for two feet working two (or more) treadles
Front-to-back	55–60 cm	clearance for the treadle swing

The pit does real work: its walls brace the buried posts and give the loom a stability a free-standing frame cannot match, and the packed earth keeps cotton yarn cool and lightly humid so it breaks less. Line the pit with brick or plaster if the soil is loose.

Setting the posts

Set the *front posts* (4″×4″, the heaviest, taking the sley and the pull of the cloth) at the weaver's side of the pit, and the *back posts* (shorter) at the far end where the warp beam sits low. The *middle posts* carry the intermediate structure. The four-to-six post arrangement gives the frame its rigidity. Bury the post feet, or seat them in the pit walls, and check with a plumb line that all posts are vertical and the pair across from each other are exactly level — the whole geometry of the cloth depends on the two beams ending up parallel and square to the warp.

Fix the two *side bars* (top rails) along the length, joining front to back posts, to carry the overhead pulley bar from which the healds and sley will hang. Brace every joint. Traditionally the frame was lashed with cord and pinned with wooden dowels rather than nailed, so that a worn member could be replaced without rebuilding — but bolts and steel pins (the 8–10 mm rods) are standard in modern builds and hold tension better.

> **Note.** Square and parallel are everything. Before going further, measure the two diagonals of the rectangle the four posts make at beam height. If the diagonals are equal, the frame is square. If not, rack it until they are, then brace. An out-of-square frame weaves crooked cloth and wears the selvedges.

3. THE TWO BEAMS — MOUNTING WARP AND CLOTH

The *warp beam* (hexagonal in section, ~11.5″ in circumference) sits low at the back; the whole length of warp — many metres — is wound onto it. The *cloth beam* (round, ~8.5″ in circumference) sits at the weaver's breast and takes up the finished cloth. The hexagonal warp beam resists slipping under the heavy wound warp; the round cloth beam lets the fabric roll on smoothly.

Mount each beam through holes in the posts so it can turn, then lock it. The traditional brake is a *bamboo or wooden peg* passed through a hole in the beam and jammed against a fixed horizontal member; modern looms use a *ratchet-and-pawl* on the beam end. Either way the rule is the same: the beam must hold absolutely against the warp tension and release one notch at a time as weaving advances. Between the beams, fit the *back rest* and *front rest* — smooth rounded bars (or small rollers) that guide the warp up off the warp beam and down onto the cloth beam, setting the working plane of the warp level at the weaver's lap.

4. HEALDS AND TREADLES — THE SHEDDING MOTION

The *healds* (heald shafts, or shafts) are the frames of corded loops that lift and lower the warp. For plain weave you need *two* heald shafts and *two* treadles. A full country heald set for a 52-inch loom runs to about 2,160 individual heald eyes ("21 pone"), made up on No. 2.0 nylon — enough for a densely-set warp across the full width.

Suspend the two heald shafts from the overhead pulley bar, over pulleys, so that they *counter-balance*: when one rises the other sinks. This is the heart of shedding — lift the odd warps, drop the even, and the shed opens. Thread one complete set of warp ends through the eyes of the front shaft, the alternate ends through the back shaft.

Below, in the pit, hinge the two *treadles* (1″×1.5″ battens) at their back ends to a fixed bar, so their free front ends can be pressed by the weaver's feet. Tie each treadle by cord to one heald shaft. Press the right treadle: its shaft drops, its partner rises over the pulley, the shed opens one way. Press the left: the sheds reverse. The cords must be tuned so that a comfortable foot-press gives a *clean, fully-open shed* — wide enough for the shuttle to fly through without grazing a warp thread. For twill and figured weaves, add shafts and treadles (three shafts and three treadles for a 2/1 twill, and so on); extra treadles of bonsoom are added for lifting more than two shafts.

> **Note.** Shed height is tuned by cord length. Too shallow a shed and the shuttle catches and frays the warp; too deep and it over-strains the threads and tires the weaver. Adjust the treadle cords, not the frame, to set it.

5. THE REED — SETTING THE FINENESS OF THE CLOTH

Figure 2 — The reed. Each gap (dent) takes one or more warp ends; dents-per-inch × ends-per-dent gives the cloth's ends-per-inch.

The *reed* is the comb — flat slips of bamboo (or steel wires) held between two ribs — that both spaces the warp evenly and beats each weft home. It is the single part that fixes how fine the finished cloth will be, so it is chosen to suit the cloth, not the other way round. The governing number is *ends per inch* (EPI) — the count of warp threads standing in each inch of cloth width.

The relation is exact and simple:

$$EPI = \text{dents per inch} \times \text{warp ends drawn through each dent}$$

So a 40-dent reed drawn one end per dent gives 40 EPI; the same reed drawn two ends per dent gives 80 EPI. The *denting* — pulling each warp end through its dent in order — is what physically sets the width and the sett of the cloth. Choose the reed by the cloth intended:

Cloth type	Typical EPI	Character
Coarse / furnishing	**20–30 EPI**	**heavy, open weave; sacking, rough cotton**
Everyday cotton	**40–60 EPI**	**shirting, saris, common wear**
Fine cotton	**80–100 EPI**	**fine muslin-grade dress cloth**
Superfine (historic)	**well over 100 EPI**	**the legendary Dhaka muslins**

To weave the finest cloth, the reed itself must be built fine enough — bamboo split into slips slender and true enough to stand a hundred or more to the inch without warping under the constant beat. The reed-maker's craft and the spinner's craft set the two ceilings on fineness between them: the spinner must draw thread fine enough to fit the dents, and the reed-maker must build the comb close enough to hold it. Fix the finished reed into the sley, held by the *reed cap*.

6. THE FLY-SHUTTLE SLEY — PICKING AND BEATING

Figure 3 — The sley carries the reed, a race for the shuttle to slide on, and a boxed picker at each end; one cord to a central handle drives the shuttle both ways.

The *sley* (or slay/batten) is the swinging frame that does the last two motions — carrying the weft across, then beating it home. Hang it from the overhead bar by two *sley swords* so it swings freely toward and away from the fell of the cloth. The sley carries four things: the *reed* (fixed above), the *sley race* (a flat board below the reed, the track the shuttle slides along), and a *shuttle box* at each end.

The fly-shuttle mechanism

Inside each shuttle box sits a *picker* — a sliding block that strikes the shuttle. A *picking cord* runs from each picker to a single *picking handle* held in the weaver's hand at the centre of the sley. A jerk of the handle to one side drives that side's picker, flinging the shuttle *from* the box on the handle's side across to the far box. One hand, one cord, and the boat-shaped shuttle flies across the race through the open shed, trailing its weft, and lands in the opposite box. The other hand stays free to work the sley.

This is the device that separated the fly-shuttle loom from the older throw-shuttle one, where the weaver had to throw and catch the shuttle by hand and so could weave no wider than two arms could reach. With the fly-shuttle, one weaver alone could throw cloth well over a metre wide, and three to four times as fast. The shuttle-guard should be *screwed* on, not fixed, so the picker can be changed when it wears.

The working stroke

With the loom threaded and tensioned, the whole cycle is: press a treadle to open the shed; jerk the picking cord to fly the shuttle across the race, laying a weft; pull the sley to beat that weft against the fell with the reed; change the treadle to swap the shed and lock the weft in; jerk the cord the other way to fly the shuttle back. *Lift, throw, beat — lift, throw, beat.* Repeated tens of thousands of times, the plane of cloth grows and is wound, notch by notch of the beam brake, onto the cloth beam.

7. DRESSING THE LOOM — FROM BARE FRAME TO WEAVING

A built loom is not yet a weaving loom; it must be *dressed* — warped and threaded — before the first pick. In order:

STEP 1 Wind the warp

Measure and wind the full set of warp threads, of equal length and tension, onto the hexagonal warp beam — traditionally with a warping frame or drum, keeping a *lease* (the cross that keeps the threads in order) on the lease rods.

STEP 2 Thread the healds (drawing-in)

Draw each warp end, in order, through the eye of a heald on the correct shaft — alternate ends to alternate shafts for plain weave. This is slow, exacting work; an error here prints as a fault down the whole length of cloth.

STEP 3 Dent the reed

Draw the warp ends through the reed dents in order, at the chosen ends-per-dent, setting the cloth's width and EPI (§5).

STEP 4 Tie to the cloth beam

Tie the drawn-in, dented warp ends to the cloth-beam apron in small even bouts, so the tension is uniform across the full width.

STEP 5 Tension and test

Wind the beams to bring the warp taut and level, lock the brake, and test the shed: press each treadle and check the shed opens clean and full across the whole width. Fly the empty shuttle across once to confirm it clears every thread. Now the loom is ready for the first weft.

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That is the whole instrument, from the pit dug in the floor to the first pick of weft — a machine of hardwood, bamboo, cord, and tension that any skilled village carpenter could build, repair, and pass on. Nothing in it could not be made locally; every part could be replaced by hand. The chapters that follow trace what happened to this self-sufficient thing — to the cotton that fed it, the spinners who supplied it, and the weavers whose hands, for a few thousand years, made it sing.

BOOK OF LOOMS · VOLUME ONE
MEASURED DRAWINGS

The Fly-Shuttle Pit Loom

A scaled orthographic plate set

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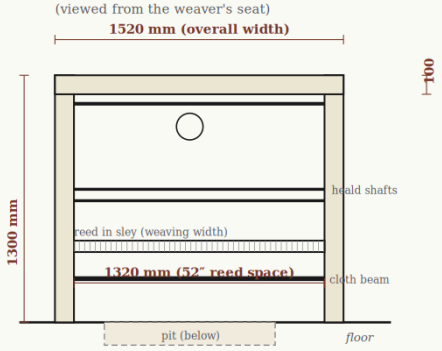
Plate 1 — General arrangement: front, side & plan (scale 1:20)
Plate 2 — The reed: full elevation & enlarged dent section
Plate 3 — Sley & fly-shuttle assembly

All dimensions in millimetres. Based on the standard 52-inch reed-space fly-shuttle frame-and-pit loom. Body-fitted and regional dimensions vary.

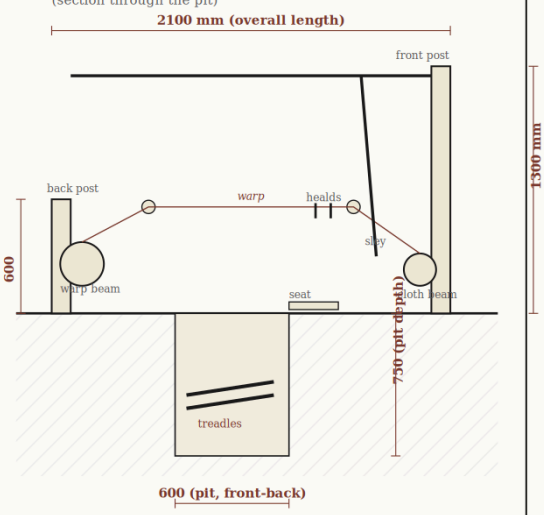
FRONT ELEVATION

(viewed from the weaver's seat)



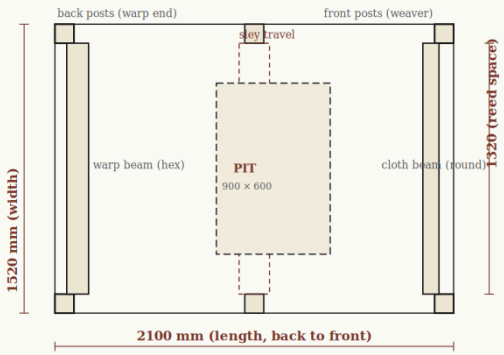
SIDE ELEVATION

(section through the pit)



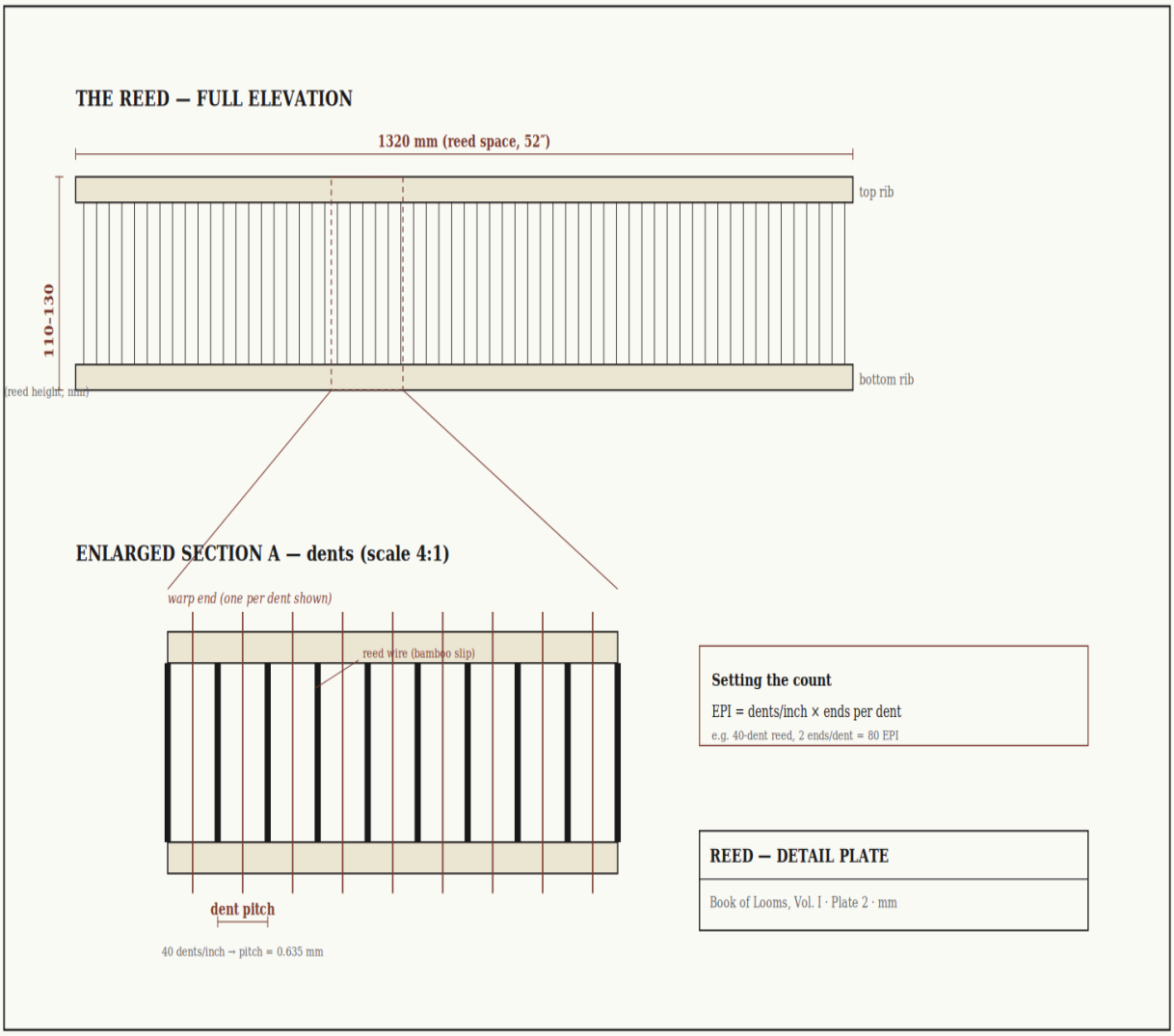
TOP PLAN

(looking straight down)



SCALE 1:20

FLY-SHUTTLE PIT LOOM — 52″ REED SPACE
Orthographic plate: front, side & plan
Book of Looms, Vol. I · Plate 1 · dims in mm · scale 1:20


THE REED — FULL ELEVATION
1320 mm (reed space, 52″)
top rib
110–130
(reed height, mm)
bottom rib
ENLARGED SECTION A — dents (scale 4:1)
warp end (one per dent shown)
reed wire (bamboo slip)
dent pitch
40 dents/inch → pitch = 0.635 mm
Setting the count
EPI = dents/inch × ends per dent
e.g. 40-dent reed, 2 ends/dent = 80 EPI
REED — DETAIL PLATE
Book of Looms, Vol. I · Plate 2 · mm

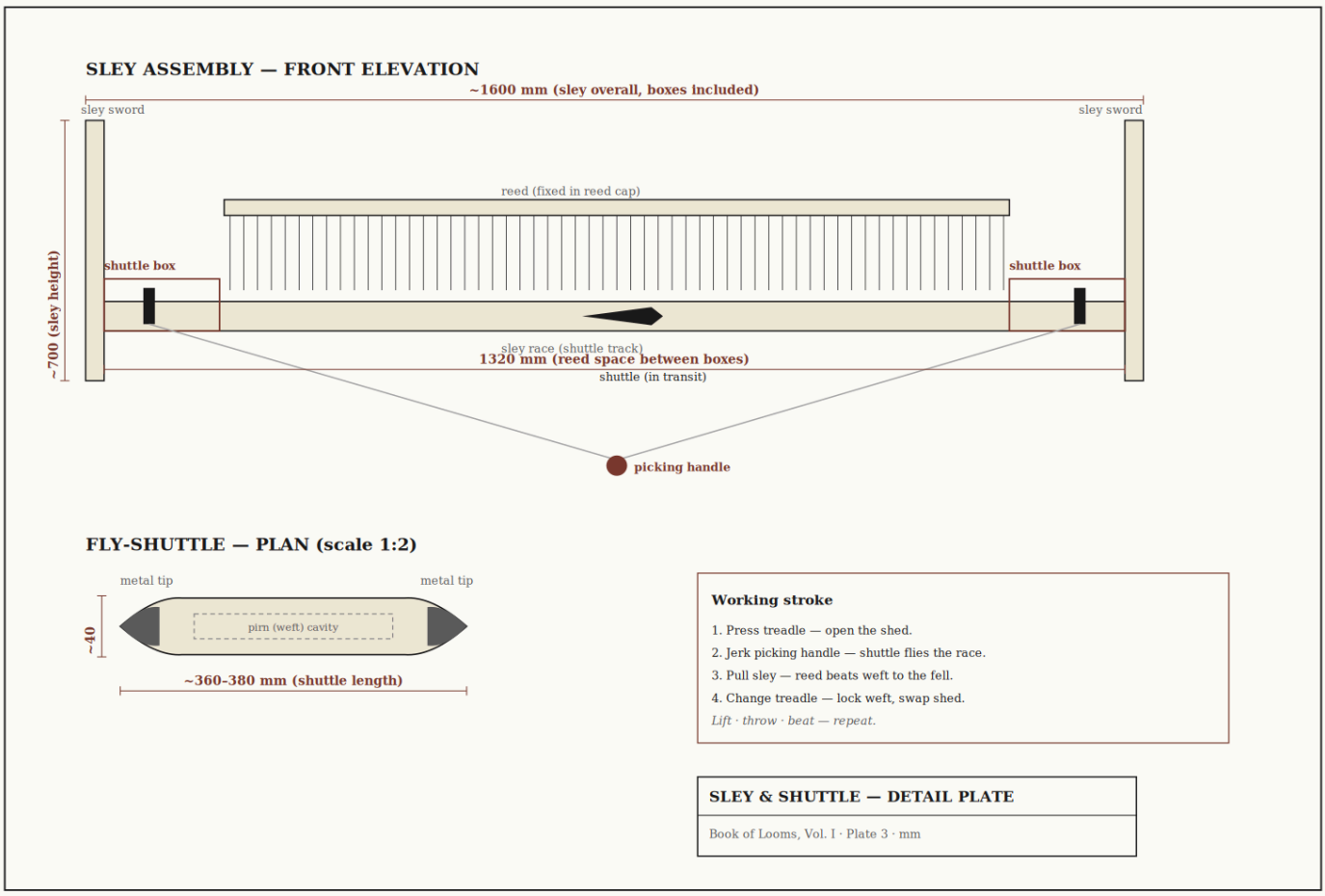

SLEY ASSEMBLY — FRONT ELEVATION
~1600 mm (sley overall, boxes included)
sley sword
sley sword
reed (fixed in reed cap)
~700 (sley height)
shuttle box
shuttle box
sley race (shuttle track)
1320 mm (reed space between boxes)
shuttle (in transit)
picking handle
FLY-SHUTTLE — PLAN (scale 1:2)
metal tip
metal tip
~40
pirn (weft) cavity
~360–380 mm (shuttle length)
Working stroke
1. Press treadle — open the shed.
2. Jerk picking handle — shuttle flies the race.
3. Pull sley — reed beats weft to the fell.
4. Change treadle — lock weft, swap shed.
Lift · throw · beat — repeat.
SLEY & SHUTTLE — DETAIL PLATE
Book of Looms, Vol. I · Plate 3 · mm

Plate 3 — Sley & fly-shuttle

CHAPTER THREE

The Family of Looms

A short history of the machine, and the branches it grew

A loom is one idea with many bodies. The idea never changes — hold one set of threads still and taut, open a gap, pass a second thread through, beat it home — but the *way* a loom holds the warp still has been solved a dozen different ways across ten thousand years, and each solution is a different loom. To know the pit loom of the last two chapters is to know one branch of a large family. This chapter walks the family tree: where each kind came from, what problem it solved, and how the branches lead, in the end, to the powered machine that would break the handloom weaver.

The family of looms. Every branch is a different answer to the single question — how do you hold the warp still? — and the pit loom sits on the horizontal-treadle branch.

1. THE FIRST LOOMS — TENSION FROM GROUND, BODY, OR GRAVITY

The earliest looms leave almost no trace, because they were made of wood and cord that rot; we know them from impressions, tomb paintings, and the one part that survives — the loom-weight. Three ancient answers to the tension problem appear across the Neolithic and Bronze Age worlds, and everything after is descended from them.

The ground (horizontal) loom

The oldest is the simplest: stretch the warp horizontally between two beams pegged flat to the earth, and crawl along it. Ground looms appear in Egypt and across the ancient Near East by the fifth millennium BCE, and a close cousin was worked in ancient China. The earth itself supplies the anchor. Its limits are obvious — the weaver bends over the work, and the cloth can be no longer than the pegged span — but it is the root of the whole horizontal line that leads, eventually, to the treadle loom and the pit.

The backstrap loom

A brilliant variation makes the *weaver* part of the loom. One end of the warp is tied to a post or tree; the other end runs to a strap around the weaver's waist. Lean back, and the body tensions the warp; lean in, and it slackens. This means the weaver is a living tension-regulator, adjusting the warp continuously by feel — a subtlety no wooden frame matches. The backstrap loom was known across Asia and, quite independently, throughout pre-Columbian America, where the finest ancient textiles of the Andes were woven on it. It is still in daily use today.

The warp-weighted loom

The third answer stands the warp up and lets gravity do the work: the warp hangs from a top beam, and bunches of threads are tensioned by tied-on weights — fired-clay or stone loom-weights that are, tellingly, the most abundant loom artefact archaeology has. The weaver works standing, beating the weft *upward*. This loom flourished from around 3500 BCE, spread through ancient Greece and across Europe into Scandinavia — ship's sails and Viking cloth were woven on it — before it faded in the medieval period. Its virtue was length: excess warp simply wound around the weights, so very long cloth was possible.

Note. These three are not a sequence but a spread — different regions solving the same problem at overlapping times. The two-beam vertical loom (warp held taut between an upper and a lower beam, letting the weaver sit and beat downward) emerged around the third millennium BCE as a fourth answer, and became the ancestor of the upright frame and tapestry looms.

2. THE GREAT LEAP — THE HEDDLE AND THE TREADLE

The single most important advance in the loom's history is not a new frame but two mechanisms that transformed an existing one: the *heddle* and the *treadle*. On the simplest looms, the weaver lifted alternate warp threads by hand or with a plain rod to open the shed — slow, and it tied up the hands. The heddle — a corded loop that grips one warp thread so a whole set can be raised together — mechanised the lift. The treadle put that lift under the *foot*, freeing both hands entirely.

This is the birth of the *horizontal treadle loom* (the shaft loom), which spread west from Asia and was widespread by around the tenth century CE. It is the direct ancestor of the Indian pit loom of the previous chapters: feet work the treadles below, hands work the shuttle and beater above, and the whole rhythm of *lift, throw, beat* becomes possible in one body. Almost every later loom, hand or powered, is built on this treadle-and-heddle principle. When you sit at the pit loom, you sit on the main trunk of the family tree.

3. TWO DIRECTIONS — TOWARD PATTERN, AND TOWARD SPEED

From the treadle loom the family divides along the two things weavers always wanted more of: richer *pattern* and greater *speed*. These two ambitions drive the rest of the story, and — as the pit-loom chapter already hinted — they often pull against each other.

The pattern branch: draw loom to Jacquard

To weave a figured cloth — a brocade, a damask, a patterned silk — the weaver must raise not simple alternate threads but arbitrary *groups* of warp, differently for every row. The *draw loom*, developed in China (with figured silks well established by the Han era), solved this by adding a second person: a *drawboy* who sat above the loom and hauled up the required warp groups by cords, row after row, while the weaver wove. It made astonishing cloth — and it was slow, and it consumed a child's labour.

The long effort to mechanise the drawboy runs through a chain of French inventors — Bouchon's perforated paper band (1725), Falcon's punched cards (1728), Vaucanson's machine (1745) — and culminates in Joseph-Marie Jacquard's loom of 1804, where a chain of *punched cards* raised exactly the warp threads each row required, automatically. The Jacquard head did the drawboy's job without error and without the boy. Its punched cards were, famously, an ancestor of the programmable machine — a thread that runs from the loom straight to the computer.

The speed branch: fly-shuttle to power loom

The other branch chases speed. John Kay's *fly-shuttle* of 1733 — the mechanism fitted to the pit loom of the last chapter — let one weaver fling the shuttle across by a jerk of a cord, doubling output and allowing cloth wider than the arms could reach. But it stayed a *hand* loom: muscle still drove every motion.

The fly-shuttle's speed created a bottleneck — weavers now outran the spinners — which drove the mechanisation of spinning (Hargreaves' jenny, Arkwright's water frame, Crompton's mule), which in turn flooded the trade with yarn and demanded faster weaving still. Edmund Cartwright's *power loom*, patented in 1785, answered it: a loom whose shedding, picking, and beating were driven by water wheel or steam engine, not by human hands. Early versions were crude and hated — handloom weavers, rightly fearing for their livelihoods, burned factories — but by around 1820, refined by Horrocks and Roberts, the power loom was commercially unstoppable. Within a single lifetime, every step from raw fibre to finished cloth had passed from the hand to the machine.

4. THE CHRONOLOGY AT A GLANCE

Dates for the ancient looms are approximate first-appearances, since the evidence is fragmentary; the industrial dates are firm.

Date	Loom / device	What changed
c. 5000 BCE	Ground / horizontal loom	warp pegged flat to the earth; the horizontal line begins
c. 3500 BCE	Warp-weighted loom	vertical warp tensioned by hung weights; weaver beats upward
c. 3000 BCE	Two-beam vertical loom	warp held between two beams; weaver may sit and beat down
antiquity	Backstrap loom	body tension; independently in Asia and the Americas
Han era	Draw loom	a drawboy lifts warp groups; figured silks become possible
to c. 10th c. CE	Horizontal treadle loom	heddle + treadle free the hands; ancestor of the pit loom
1725–1745	Bouchon, Falcon, Vaucanson	perforated paper and punched cards begin to automate pattern
1733	Fly-shuttle (Kay)	one hand flings the shuttle; wider, faster hand-weaving
1785	Power loom (Cartwright)	weaving driven by water/steam, not muscle
1804	Jacquard loom	punched cards replace the drawboy; programmable patterning
c. 1820→	Refined power looms	commercially viable; the handloom trade begins its collapse
19th–21st c.	Automatic & computer looms	rapier, air-jet, CNC; the hand leaves the loom entirely

5. WHERE INDIA STOOD — AND WHAT THE TREE FORETELLS

India sat, for most of this history, on the horizontal-treadle and draw-loom branches, and sat there supremely well. On pit looms and draw looms, with hand-spun desi cotton and a reed-maker's and spinner's craft honed over centuries, Indian weavers made cloth — the fine muslins above all — that the world crossed oceans to buy. The family tree, read from India's side, is not a ladder of progress but a map of a craft that had reached a summit by hand.

But the tree also foretells the break. The two branches that Europe pushed hardest — the power loom for speed, the Jacquard for pattern — were the two that turned weaving from a distributed rural craft into a centralised industrial one. When those machines arrived, backed by empire and by mill-spun thread of a foreign staple, they did not merely compete with the Indian handloom; they were engineered, and their trade arranged, in ways that unmade it. That unmaking — how a civilisation that had perched at the top of the craft was pushed off it — is the story the rest of this book must tell. We have the instrument, and now the family it belongs to. Next we turn to the thread that fed it: the cotton, and the hands that spun it.

Plate 3 — Sley & fly-shuttle